

Potential avian selenium exposure of current and proposed drainage water management in the San Joaquin Valley



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Introduction

- ❖ Drainage is poor in much of the southern San Joaquin Valley due to underlying clay layer
- ❖ San Joaquin Valley marine history and seleniferous soil influx from Coast Range requires flushing of salts from crop root zone
- ❖ Installed subsurface tile drains remove shallow groundwater and leached salt water
- ❖ “Drain water” or “tile water” routed away from drained acreage to deposition site



San Luis Drain Drainwater Disposal

- ❖ In 1984-1985, aquatic birds at Kesterson Reservoir were found to have near zero reproductive success, and most adult birds were dying (San Luis Drain terminus).
- ❖ Problems linked to high Selenium (Se) levels in aquatic food web. San Luis Drain not completed.

Evaporation Pond Disposal



Evaporation Pond Disposal

❖Evaporation ponds are often the primary source of aquatic bird breeding habitat in southern San Joaquin Valley

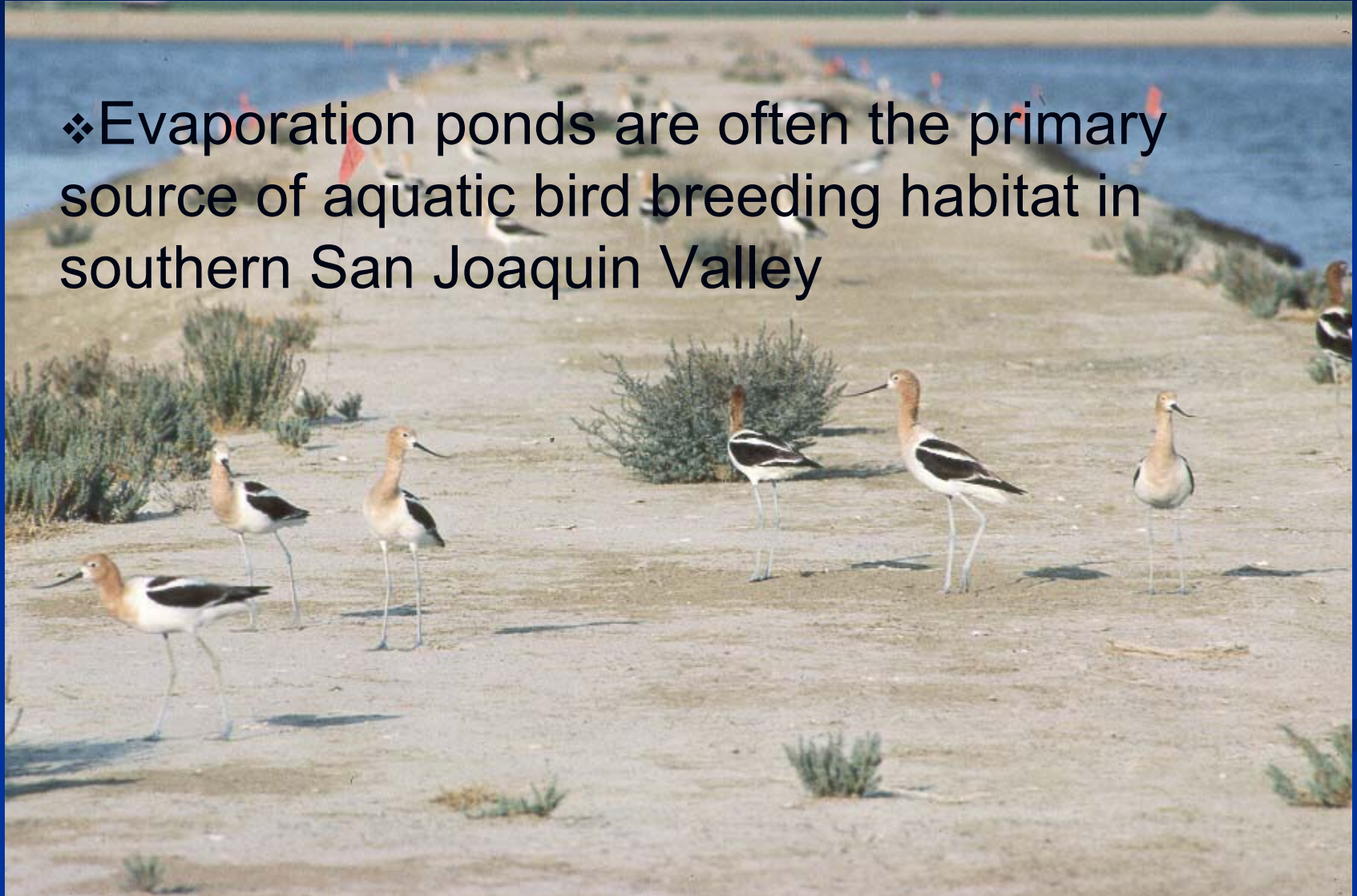


Photo: J. Skorupa

Evaporation Pond Disposal

- ❖ Evaporation ponds contain salty, nutrient rich, warm, highly productive water



Evaporation Pond Disposal



Evaporation Pond Disposal

- ❖ In 1989, USFWS documented that evaporation ponds pose ecotoxic risks to wildlife similar to those observed at Kesterson Reservoir
- ❖ In 1998, there were 4,900 acres of evaporation ponds remaining in operation
- ❖ USBR San Luis Drainage Feature Re-Evaluation (2003) identifies an alternative that would result in creation of an **additional 5,000 acres** of evaporation ponds (EIS in prep.). USBR says that it “will make evaporation ponds unattractive to birds.”

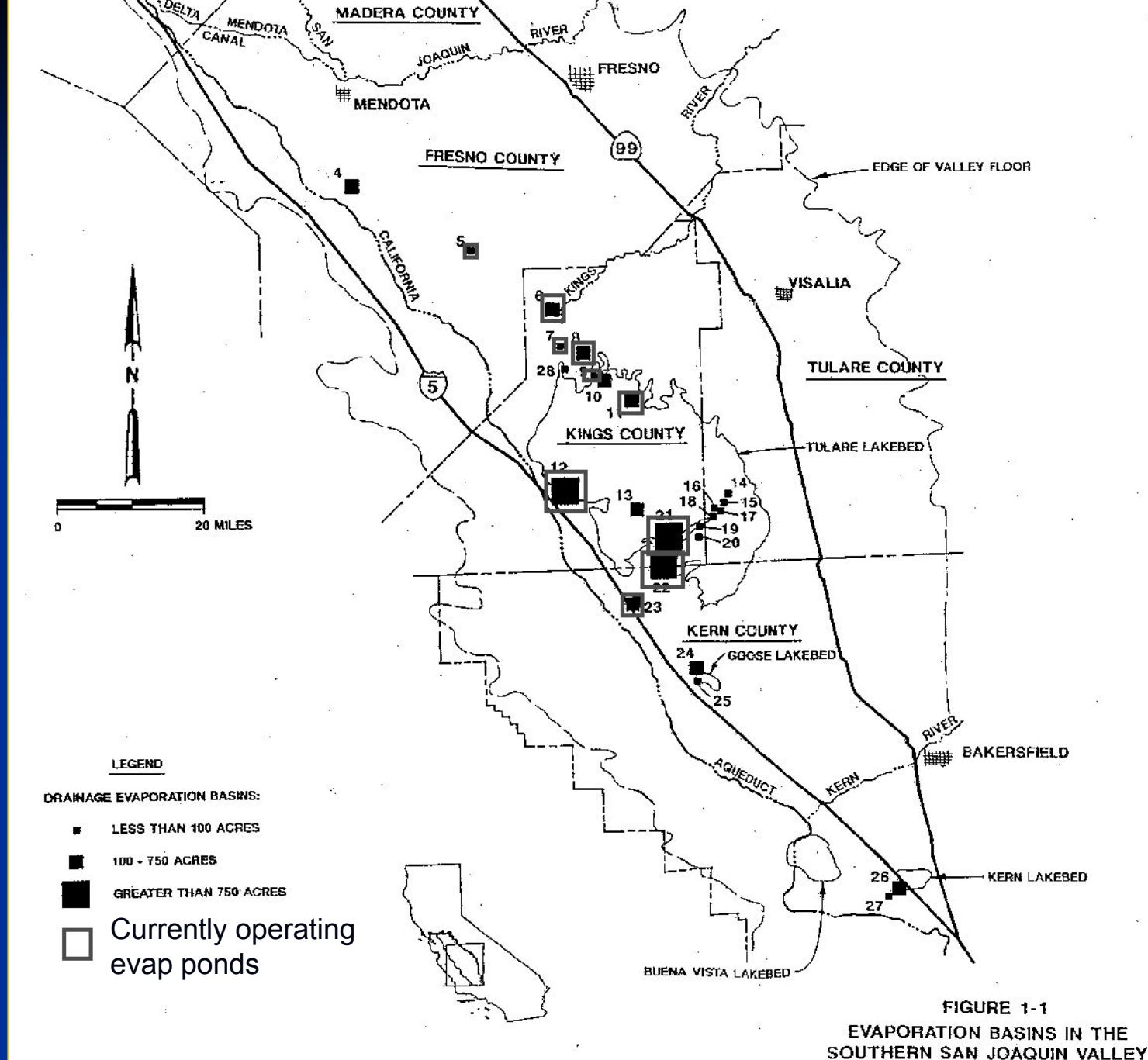
	Source*	Water (µg/L)	Avian eggs	Effects on Wildlife
SLD Term.	Kesterson	230-420	2.3- 180	4-49% inviable eggs

Evap. Ponds	Tulare Basin, Sumner Peck Ranch	460-943	15- 148	33-50% teratogenic eggs
	Lost Hills	83-671	2.1- 164	2-16% teratogenic shorebird eggs
	Tulare Lake Drainage District (S)	19-30	1.9-80	14-45% teratogenic duck eggs
	Rainbow Ranch (Andrews Ag)	158-212	2.5- 115	4-10% teratogenic shorebird eggs

IFDM	Red Rock Ranch	1151-2114	7.2-81	14-57% teratogenic shorebird eggs
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5 (µg/L) =EPA freshwater
chronic criteria

*From: Skorupa 1998, in Environmental Chemistry of Se



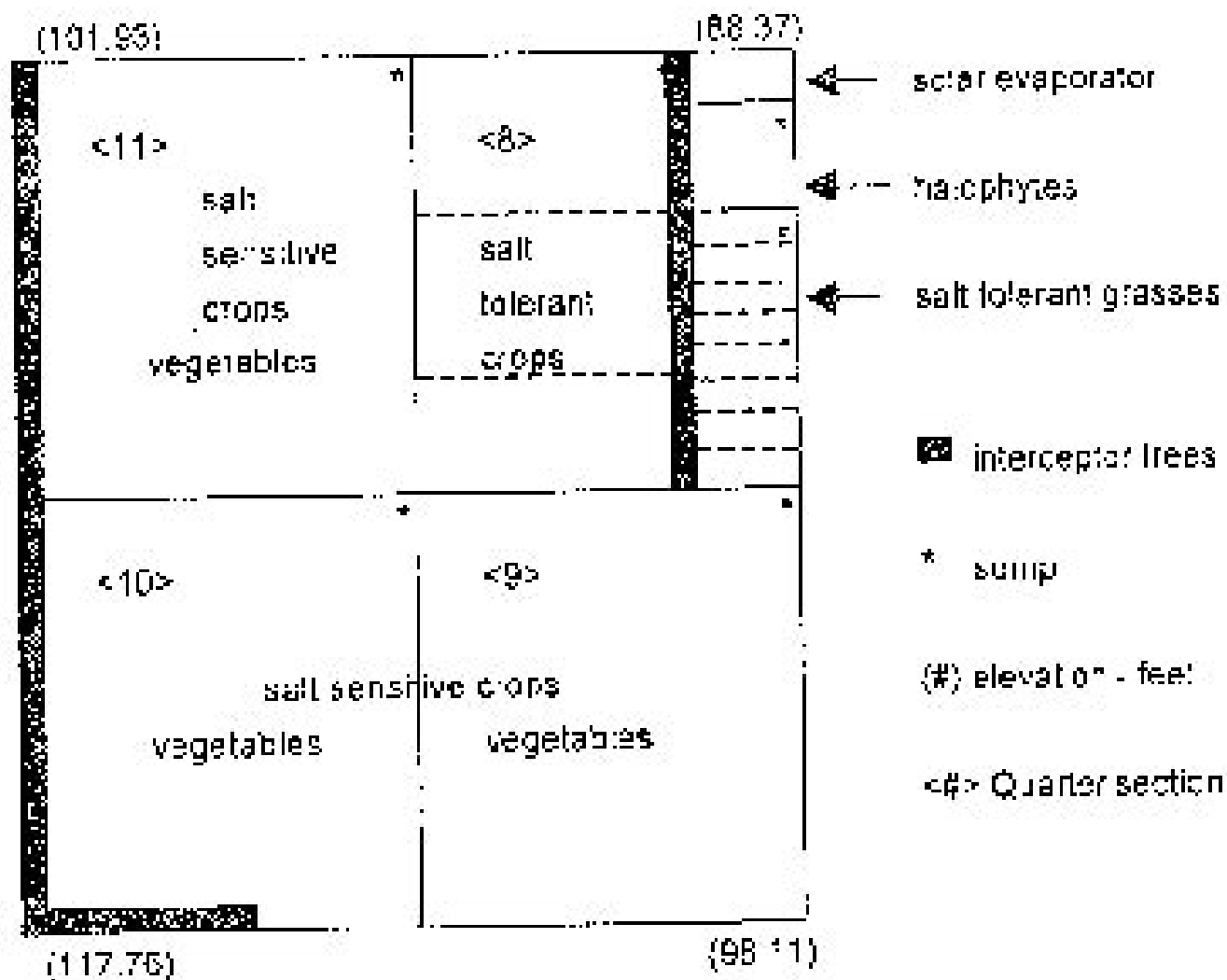
IFDM

(Integrated on-Farm Drainage Management)

- ❖ System of sequential reuse. Increasingly saline water applied to series of increasingly salt tolerant crops
- ❖ Produces low volumes of terminal wastewater in comparison to more traditional disposal methods
- ❖ Highly concentrated water is discharged to a terminal solar evaporator, at rates = to evaporation
- ❖ As a result, no ponded water should occur, minimizing Se exposure to shorebirds


Red Rock Ranch


Integrated On-Farm Drainage Management



Red Rock Ranch IFDM



 **California Regional Water Quality Control Board**
Central Valley Region
Robert Schneider, Chair

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18 April 2001

NOTICE OF VIOLATION

Mr. John Diener
Diener Family Trust
P.O. Box 384
Five Points, CA 93724

Mr. Red Martin
Westside Resource Conservation Service
3763 E. Robinson Avenue
Fresno, CA 93726-5917

FAILURE TO SUBMIT NEW REPORT OF WASTE DISCHARGE AND ENVIRONMENTAL ANALYSIS, DIENER FAMILY TRUST, RED ROCK RANCH AGROFORESTRY DEMONSTRATION PROJECT, FRESNO COUNTY

On 11 October 2000, you were issued a Notice of Violation, which found you operating in violation or threatened violation of conditions of Waste Discharge Requirements Order No. 94-298. You submitted a brief report indicating steps you would take to eliminate ponding of water and come into compliance with Order 94-298. You were also requested to submit a new Report of Waste Discharge (RWD) including an application form (Form 200), and an operations plan that describes the changes in operation and responsibility of the project. To date we have not received this information.

The Department of Water Resources (DWR) prepared an administrative draft negative declaration for you; however, the negative declaration has not been finalized. On 22 March 2001, we met with you, the DWR, and Westside Resource Conservation Service, and discussed compliance issues. At the meeting you indicated that you would finish the RWD and Negative Declaration. In order to update Order 94-298, a comprehensive project description and California Environmental Quality Act (CEQA) analysis must be completed.

The California Water Code, §13260, says that persons shall file with the appropriate regional board a complete RWD relative to any material change or proposed change in character, location, or volume of the discharge. The California Water Code, §13264, says that persons shall not initiate any new discharge or make any material changes in any discharge prior to either:

- Issuance of Waste Discharge Requirements (WDRs) by the Board;
- Issuance of a Conditional Waiver of WDRs; or
- The expiration of 120 days after the Board receives a complete RWD, provided the requirements of CEQA have been satisfied.

Shelton

Gray Davis
Governor

Shelton

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Governor

California Environmental Protection Agency
Recycled Paper

Red Rock Ranch IFDM

(Five Points, CA)

- ❖ Studies of breeding water birds began on-site in 1996 (USFWS), after RWQCB reported observations of breeding shorebirds and ponded water
- ❖ The water ponded in the solar evaporator contained 11,000 ppb, and the water discharged to the halophytes was 1600 ppb
- ❖ The status of 17 BNS embryos were determined, 56.7% of which were deformed, the highest Se-induced rate of avian teratogenesis reported by any field study to date. Mean egg Se content of 58 ppm

Red Rock Ranch Halophytes



Red Rock Ranch

- ❖ During 1997-1999, follow-up on Red Rock's breeding birds was inconsistent due to USFWS funding constraints
- ❖ In 2000, USFWS funding and Prop 204 (DWR) funding was secured for a systematic study of IFDM systems and their potential impact to breeding birds

Study Objectives

- ❖ Assess the overall use of IFDM sites by breeding birds (all species)
- ❖ Assess the Se exposure of eggs produced by birds nesting at IFDM sites (all species)
- ❖ Assess the impact of Se exposure on egg viability
- ❖ Identify management changes at IFDM systems that reduce Se exposure to avian wildlife
- ❖ Identify appropriate mitigation measures, if needed (USFWS)

Methods

- ❖ During the avian breeding season (approximately Mar 1-Aug 1) Red Rock Ranch was visited weekly
- ❖ Bird usage of the drainage reuse area (solar evaporator, halophyte plots, eucalyptus plot, salt tolerant grass plots, and adjacent areas) was evaluated
- ❖ Thorough nest searches were conducted, and detected nests were monitored to completion
- ❖ Eggs were collected from each nest, unless a sufficient sample size for that species had been obtained

Methods, cont.

- ❖ Embryos in collected eggs were assessed and submitted for Se levels and a trace metals scan. A full metals scan was conducted on selected samples
- ❖ Presence of ponded water in the drainage reuse area was documented. % coverage and approximate depth was estimated
- ❖ Presence of aquatic invertebrates (ID to family level) in any ponded water was noted, and a rough abundance estimation was made

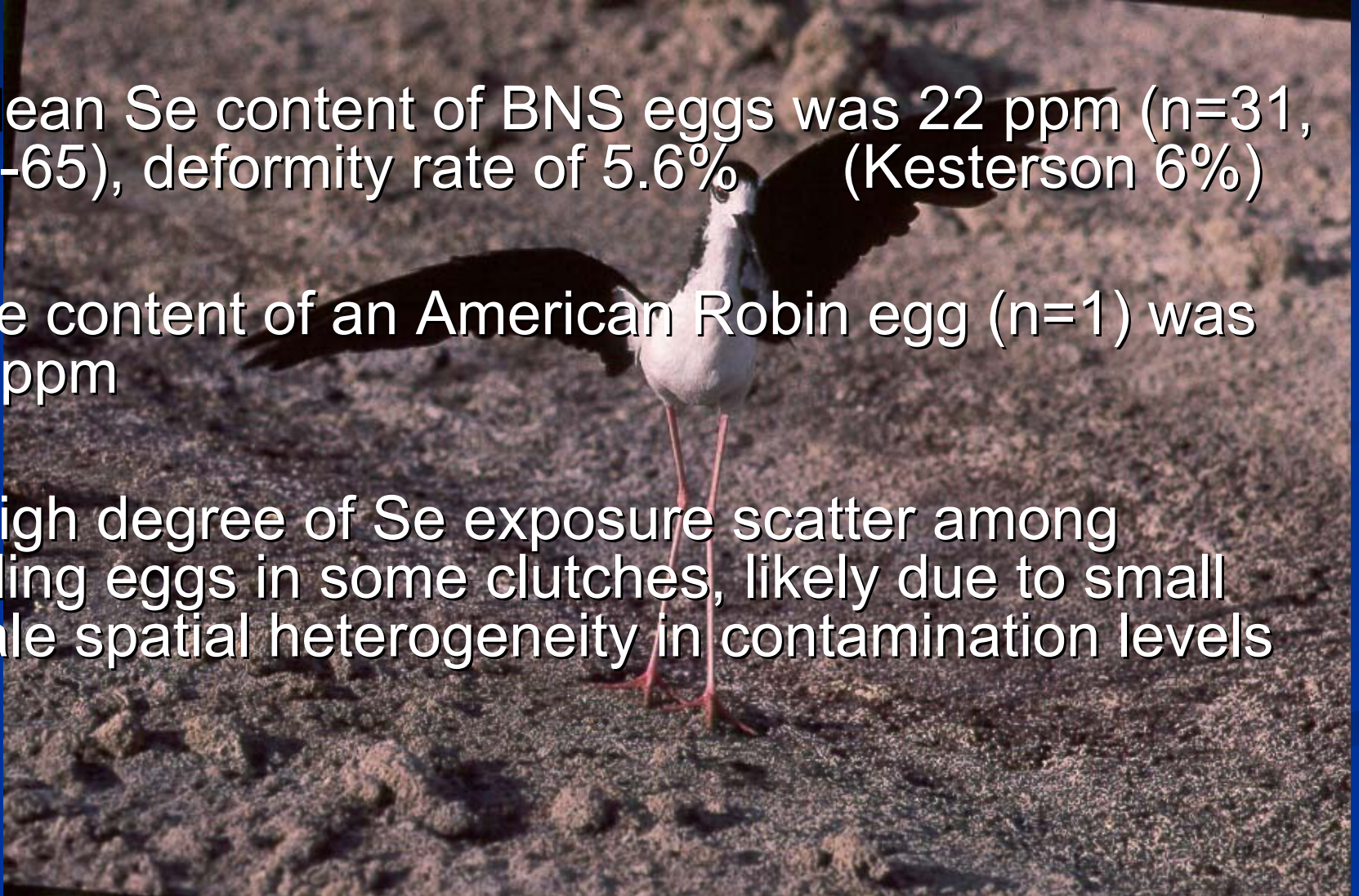
Results (2000)

- ❖ 13 species confirmed as nesting at Red Rock Ranch, for a total of 84 nests
- ❖ Nesting occurred in all habitat types on site, although the halophytes and salt tolerant grass plots were more attractive to shorebirds such as BNS
- ❖ From the 84 nests, 145 eggs were collected, of which 79 had assessable embryos, 13 of which could be assessed for malpositioning

Species	# of Eggs Collected
Black-necked Stilt	33
Killdeer	18
American Avocet	0
Mourning Dove	1
House Finch	15
Red-winged Blackbird	10
Brewer's Blackbird	40
House Sparrow	13
White-tailed Kite	0
American Crow	0
American Robin	1
Western Kingbird	2
Brown-headed Cowbird	12

Results (2000)

- ❖ Mean Se content of BNS eggs was 22 ppm (n=31, 3.5-65), deformity rate of 5.6% (Kesterson 6%)
- ❖ Se content of an American Robin egg (n=1) was 27 ppm
- ❖ High degree of Se exposure scatter among sibling eggs in some clutches, likely due to small scale spatial heterogeneity in contamination levels



Results

- ❖ Complete egg chemistry data for 2000-2002 pending
- ❖ Black-necked Stilts nested on-site 2000, 2001, and 2002, meaning that sufficient ponded water to induce nest establishment was present in all 3 years
- ❖ Low numbers of assessable embryos obtained in 2001-2002, due to high rate of (early) nest destruction from farm operations
- ❖ Severely deformed BNS embryo collected in the Salt Tolerant Grass Plots on 7-15-2002

- ❖ Absence of eyes and limbs
- ❖ malformed upper bill
- ❖ reduced & malformed lower bill
- ❖ greatly reduced body trunk size
malshaped head





Summary

- ❖ IFDM sites can result in Se-induced teratogenesis in birds (can be severe)
- ❖ Proper water (none!) management of IFDM sites can significantly reduce Se exposure. “Best” year at Red Rock still at or just below Kesterson levels for same species
- ❖ Shorebirds and terrestrial insectivores (American Robin, Western Kingbird, Loggerhead Shrike) were at greater Se exposure risk than granivores (House Finch, European Sparrow)

Summary, cont.

- ❖ Unknown if Red Rock is “best” or “worst” case scenario....needs to be evaluated carefully
- ❖ Additional IFDM sites need to be evaluated as they become operational
- ❖ Andrews Ag (formerly Rainbow Ranch) IFDM was evaluated in 2001 in less detail. No significant ponded water problems or avian nesting were detected.
- ❖ IFDM drainage water management preferable to evaporation ponds, because of numbers of birds affected

Summary, cont.

- ❖ Andrews Ag (formerly Rainbow Ranch) converted from a 100 acre evaporation basin to IFDM (2001). However, most IFDM sites will likely be in addition to, rather than instead of, evaporation ponds
- ❖ Potential “scale up” related impacts of IFDM unknown; larger salt tolerant grass and halophyte plots may significantly increase attractiveness of IFDM sites
- ❖ IFDM Best Management Practices (BMPs) will be published in 2004 (USFWS and DWR)

SB1372 (Machado)

- ❖ Introduced February 8, 2002, signed by Governor Gray Davis on September 15, 2002
- ❖ Despite IFDM systems still being described as “experimental,” growers lobbied for passage of this bill
- ❖ No opposition; sold to environmental groups as a method to “clean up the San Joaquin River,” and bird safe because “the discharge to the solar evaporator does not result in standing water”

SB1372

- ❖ Exemption to TPCA for Se disposal to solar evaporators (terminal portion of IFDM), so that water with over 1 ppm Se can be discharged (EPA chronic criteria 5 ppb)
- ❖ SWRCB tasked with developing emergency set of regulations
- ❖ 25209.12 (b)(1): “ The solar evaporator is designed, constructed, and operated so that, under reasonably foreseeable operating conditions.....does not result in standing water.”

SB1372

- ❖ 25209.12 (c) “Avian wildlife is adequately protected” (no definition provided)
- ❖ 205209.12 (c)(2): “guidelines shall include technical advice developed in consultation with DFG and USFWS that **may be** used....to identify observed conditions relating to the operation of solar evaporator that indicate an unreasonable threat to avian wildlife.”
- ❖ No definition of “unreasonable threat”

SB1372

- ❖ SWRCB currently developing guidelines
- ❖ Most recent draft has eliminated all biological monitoring requirements, and increased allowable ponded water to 2 cm in depth
- ❖ Optimum shorebird foraging habitat is water 3-5 cm in depth, with associated mudflats and dense invertebrate prey items
- ❖ If guidelines finalized as currently drafted, severe Se exposure to shorebirds at IFDM sites likely

SB1372

- ❖ SWRCB regulations only addressing solar evaporator, not the proceeding IFDM sequences such as the halophytes and salt tolerant grasses
- ❖ DWR/USFWS study found that the halophyte and salt tolerant grass plots are more attractive to shorebirds, and have documented Se-induced teratogenesis in eggs at these locations
- ❖ SWRCB to hold public workshop in May, public draft available for review soon

Acknowledgements

Landowners

- ❖ John Deiner, Red Rock Ranch
- ❖ Mike Andrews, Andrews Ag

Funding

- ❖ DWR Prop 204
- ❖ USFWS